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RESEARCH ARTICLE



# Socio-cultural aspects of farmers' perception of the risk of climate change and variability in Central Ethiopia

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**ABSTRACT**

There is a dearth of evidence on the socio-cultural aspects of climate change risk perception in developing countries. This study investigates the variation in farmers' perception of the risks of climate change and variability by their socio-cultural characteristics. Data were collected from 810 randomly selected households in central Ethiopia using a structured questionnaire. Polling, a maximum likelihood prediction method of multivariate analysis that jointly evaluates the combined roles of different variables, allowing for non-parametric interactions, was used to analyse the data. The results show that households with a high risk perception have high accurate knowledge about climate change, experience of climatic events, value both societal and individual responsibilities to reduce the impact of climate change, and reside in the midland agro-ecological settings. On the other hand, a low descriptive norm, low social capital, lack of access to media, low level of education, and valuing autonomy characterize households with a low risk perception. The findings entail that communication strategies focusing on evidence-based knowledge about causes and consequences of and responses to climate change, past experience of climatic events, as well as fostering self-transcendence and openness-to-change values raise risk perception to engage farmers in adaptation actions.

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**KEYWORDS**
Knowledge; experience; norm; value; polling

## 1. Introduction

Human beings have experienced numerous natural and man-made risks for a historically long period of time. They have also effectively responded to these risks to ensure their survival and improve their livelihood. Unlike many other risks, climate change and variability (CCV) is unique in that it is not easily recognized due to gradual process of change (Weber, 2010). Perception plays a crucial role in recognizing it and becoming motivated to respond. For a risk to prompt action, it must first be defined and perceived as a real threat. According to Dessai et al. (2004), risk is defined both externally and internally. It is externally defined by experts based on the scientific analysis of a phenomenon and using normative criteria. It is defined internally by individuals based on experienced or anticipated impact. Although both are important, the internal definition is more important for risk perception. This is mainly because it is difficult for the public to interpret long-term changes in climatic patterns of an area and the complex processes underlying the changes (Marlon et al., 2019), as well as the limitations of experience-based learning in changing attitudes towards CCV (Dessai et al., 2004).

Scientific forecasts widely report changes in the climate and call for action to reduce their impact. Despite growing scientific consensus about climate change, strong political interest to implement adaptation and mitigation actions, and wider media coverage on the subject, public concern for and action to respond to climate change are limited (Whitmarsh, 2011). Individual response to CCV is a function of perceiving it as a risk that should be acted upon (Dessai et al., 2004). However, not all people consider climate change a concern. Households in the same physical setting may respond to CCV differently due to variations in their mental analysis and understanding of the risks. Furthermore, CCV is not the only source of risk for farmers to be concerned about. In the context of vulnerability to multiple risks, people give less priority to CCV when other competing risks are more salient (Whitmarsh, 2011). Consequently, there is variation in the concern about climate change.

There is a growing interest in understanding risk perception for effective adaptation and disaster risk management. According to Deressa et al. (2011), adaptation is a two-stage process involving perception followed by adaptation responses. It is based on the assumption that perception motivates people to take action and that underestimation of risk can constrain adaptation (Fisher & Snapp, 2014; Grothmann & Patt, 2005). Plenty of empirical works in the past years attest that risk perception is one of the necessary requirements for adaptation. For instance, studies in Ethiopia (Gebrehiwot & Van Der Veen, 2015), Malawi (Fisher & Snapp, 2014), Tanzania (Below et al., 2015), Nepal (Joshi et al., 2017), and Sri Lanka (Esham & Garforth, 2013) show the positive effect of risk perception on the likelihood of adaptation to climate change. Moreover, the success of adaptation strategies hinges on the extent to which CCV is perceived as a risk (Patt & Schröter, 2008). Risk perception also significantly explained preparedness for flood risk management (Mabuku et al., 2018).

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A large body of work has examined demographic and socio-economic determinants of risk perception. Though the empirical relationships are not consistent and conclusive (Wolf & Moser, 2011), and there is no clearly established theoretical framework linking socio-demographic factors and risk perception (Duinen et al., 2015), most studies reported variation in risk perception by demographic characteristics (Akerlof et al., 2013; Deressa et al., 2011; Duinen et al., 2015; Whitmarsh, 2011). Risk is also perceived based on economic resources and in response to maximizing economic benefits. Access to economic resources such as size of land and income positively influence not only risk perception (Deressa et al., 2011) but also behavioural intention to undertake farm-level adaptation (Gebrehiwot & Van Der Veen, 2015) and preparedness for disaster risk management (Mabuku et al., 2018). Duinen et al. (2015) found that farmers' exposure to drought due to locational factors and sensitivity to drought due to economic activities increase risk perception. Economic factors also interact with other household characteristics to shape perception. For instance, high economic capacity, when coupled with extensive knowledge about climate change, may reduce risk perception and preparedness to take action due to a feeling of 'invulnerability' (Mabuku et al., 2018).

Nevertheless, less attention is paid to the roles of the socio-cultural contexts in which farmers experience a risk. Risk is socially constructed in a rich and complex socio-cultural setting in which different groups are predisposed to duly consider some risks while discounting others (Leiserowitz, 2006; Patt & Schröter, 2008). Thus, people's understanding about and responses to CCV are dissimilar due partly to socio-cultural reasons (Weber, 2010). There is scant evidence on the roles of these factors in shaping climate change risk perception in developing countries. Most of those studies were conducted in developed countries, the results of which are either less generalizable or not generalizable to developing countries due to differences in their economic and cultural settings (Smith et al., 2012). Against this backdrop, the objective of this study is to investigate the socio-cultural characteristics of households associated with varying levels of climate change risk perception. This characterization helps to disentangle the underlying factors of variation in risk perception. It may also enhance tailored intervention aimed at enabling households to recognize the threats and motivating them to take action.

The contribution of this study lies in its use of a comprehensive analytical framework integrating a broad range of socio-psychological determinants of risk perception with high explanatory power (van der Linden, 2015). We also used a holistic approach to measure the latent constructs constituting the framework. Many studies defined perception by focusing on an increase or decrease in temperature and/or rainfall (Deressa et al., 2011; Hameso, 2017; Lasco et al., 2016). Although it gives valuable insights, the observation of changes in temperature and rainfall shows only an awareness of climate change (Duinen et al., 2015; Gebrehiwot & Van Der Veen, 2015). Risk perception includes farmers' concern about these changes, the impacts of these changes on their lives, and seriousness of the changes to the households and the community (van der Linden, 2015). Unlike most previous studies that focused on self-assessed responses (Stoutenborough & Vedlitz, 2014), we used a wide-ranging domains to measure the farmers' climate-related knowledge. We also considered the openness-to-change vs. tradition value dimension where related evidence is scant (Corner et al., 2014). Furthermore, we used an innovative multivariate analysis method called 'Polling' that overcomes the functional specification problem of standard regression techniques associated with modelling a large number of categorical explanatory variables.

## 2. Theoretical considerations

The study of risk perception has evolved over time with theoretical contributions from several disciplines.

### 2.1. Knowledge deficit model and the role of the cognitive factor

According to the Knowledge Deficit Model, the proper evaluation of a risk is constrained by a lack of knowledge about climate change (Stoutenborough & Vedlitz, 2014). The model hypothesizes that people's low level of concern about climate change and its effects on humans is attributable to a lack of scientific information and/or the capacity for scientific thinking (Persson et al., 2015) and calls for addressing these knowledge deficits to increase their concern. However, knowledge has no consistent effect on risk perception. Recent studies showed that the consistency of the relationship between knowledge and risk perception depends on the measurement of what constitutes knowledge about climate change (Shi et al., 2016). Subjective assessment of knowledge is susceptible to measurement errors, and thus studies investigating its relationship with risk perception yield inconsistent results (Stoutenborough & Vedlitz, 2014). Several studies that used objective measures support the significant positive effect of knowledge on climate change risk perception (Shi et al., 2016; Sundblad et al., 2007; Tobler et al., 2012). However, knowledge is not sufficient to cause someone to be concerned about climate change. And lower risk perception is not necessarily caused by ignorance (Stoutenborough & Vedlitz, 2014).

### 2.2. Risk-as-feelings hypothesis and the roles of affect and experience

Climate-related information is processed to raise concern in two ways: analytical processing (risk-as-analysis hypothesis) and experiential processing (risk-as-feelings hypothesis) (Slovic et al., 2004). Analytical processing refers to statistical information processes and logical reasoning while experiential processing involves affective and associative processes (Marx et al., 2007; Slovic et al., 2004). According to the risk-as-feelings hypothesis, decisions are made based on how we feel about the phenomenon (Slovic et al., 2004). This experiential mode of thinking is based on affect, an evaluative feeling of the goodness (positive) or badness (negative) of a given stimulus (Leiserowitz, 2006; Slovic et al., 2007). People experience climate-related risks in affective and emotional terms, and the vividness with which climate events are experienced determines the formation of affective judgements about the risks (Marx et al., 2007). Several studies unveiled the evidence that affective and

emotional factors positively influence climate change risk perception (Hitayezu et al., 2017; Leiserowitz, 2006).

One of the mechanisms through which affective judgements raise the concern for risks is direct experience. Climate change can be experienced indirectly through the observation of long-term changes in local weather conditions (Howe et al., 2013) or directly through the occurrence of extreme weather events (van der Linden, 2015) or through its impact (Whitmarsh, 2008). Although the evidence of the relationship between past experience and risk perception is mixed (Marlon et al., 2019), several studies found a positive effect of experience on risk perception (Akerlof et al., 2013; Frondel et al., 2017; Lujala et al., 2015). However, experience is not automatically translated into an increased perception of risk. For instance, Whitmarsh (2008) found that flood experience was not significantly associated with higher risk perception, stressing the importance of attributing the cause of the occurrence of the event to climate change to perceive it as a risk. Familiarity with a risk through persistent exposure might even reduce the perception of its riskiness due partly to psychological and emotional reactions of considering it as normal (Weber, 2010).

### 2.3. Focus theory of normative conduct and the role of the social norm

According to the focus theory of normative conduct, social norms motivate and direct action when they are made salient (Cialdini et al., 1991). Two types of social norms that influence behaviour are identified in the theory: descriptive and injunctive norms. Given that behaviour can be learned by observing the actions of others, a descriptive norm reflects the perception of a behaviour performed by other people. It motivates action by informing people about the likely behaviour of other people. An injunctive norm refers to behaviour/action an individual thinks others approve or disapprove of (Cialdini et al., 1991; Smith et al., 2012). As an informal prescriptive rule, an injunctive norm motivates action by informing people about moral values and social standards pertaining to a behaviour in a given context (Smith et al., 2012). The more individuals perceive that others are taking action to combat the risk of climate change (i.e. high descriptive norm) and the more people perceive that action is also expected of them (i.e. high injunctive norm), the higher their risk perception of climate change (van der Linden, 2015). The positive impact of social norms on a broad range of human behaviour has been reported in several studies (Farrow et al., 2017; Schultz et al., 2007; Smith et al., 2012).

### 2.4. Value basis of environmental concern and the role of value orientations

Value is an integral part of a community's socio-cultural characteristics that shapes the framing of risks (Corner et al., 2014). According to Schwartz's value theory (Schwartz, 1994), values that guide people's lives are generally arranged along two dimensions of value orientation comprising 10 types of values. These are self-transcendent (universalism, benevolence) vs. self-enhancement (hedonism, achievement, power) and openness to change (self-direction, stimulation) vs. conservatism (security, tradition, conformity). In the related theoretical developments focusing on environmental behaviour, three value orientations (egoistic, altruistic, and biospheric) were identified and widely used in risk perception research. Egoistic value focuses on self-interest; altruistic value focuses on the welfare of other people; and biospheric value involves care for the environment (De Groot & Steg, 2010; Steg & De Groot, 2012).

Several studies have reported that these value orientations have varying effects on risk perception. Individuals' adherence to altruistic and biospheric values, which are equivalent to self-transcendent and conservation values, respectively (Corner et al., 2014), is found in many studies to be positively associated with risk perception and the intention to take action, whereas egoistic value, which is a self-enhancement value, is negatively associated with risk perception (De Groot & Steg, 2008; De Groot & Steg, 2010; Slimak & Dietz, 2006; Stern & Dietz, 1994). The environmental behaviour of people with egoistic value is dependent on the cost–benefit analysis of certain behavioural actions in which positive environmental behaviour is endorsed when the individual benefit outweighs the cost (De Groot & Steg, 2008; Steg & De Groot, 2012). For people with altruistic and biospheric values, however, the cost–benefit analysis takes into account other people and the ecosystem, respectively, instead of being self-centred. In general, people with self-transcendent values are more concerned about climate change (Corner et al., 2014; Schultz & Zelezny, 1999). Although there are few studies linking risk perception to openness-to-change vs. conservatism values, little of the available evidence shows that openness-to-change increases the concern for environmental problems (Schultz & Zelezny, 1999). According to value basis theories of environmental concern, value affects behaviour indirectly through the development of beliefs (on the human-environment relationship, adverse effects of environmental conditions on things that individuals value, individuals' responsibility to take action) and the construction of attitudes in a given social context (Schultz & Zelezny, 1999; Stern et al., 1999).

### 2.5. The role of socio-demographic and economic factors in shaping risk perception

The extant literature shows that socio-demographic characteristics of households explain the variation in risk perception, though inconsistently. Females have a higher risk perception than males (Akerlof et al., 2013; Ayal & Leal Filho, 2017; Hitayezu et al., 2017; Leiserowitz, 2006; Lujala et al., 2015; Sundblad et al., 2007). While Milfont (2012) found that younger people have a higher risk perception, older people had it in other studies (Ayal & Leal Filho, 2017; Deressa et al., 2011; Hitayezu et al., 2017), and age had no significant effect in some studies (Akerlof et al., 2013; Sundblad et al., 2007). Better educated individuals are more concerned about or have a higher perception of climate change (Ayal & Leal Filho, 2017; Lujala et al., 2015), though there are studies that show a negative effect of education on risk perception (Slimak & Dietz, 2006) or no significant effect (Akerlof et al., 2013; Milfont, 2012; Sundblad et al., 2007). Ayal and Leal Filho (2017) found that poor farmers perceive climate change risk well.

Conversely, Deressa et al. (2011) found a positive effect of income on risk perception, whereas income had no significant effect on risk perception in a study by Akerlof et al. (2013). Risk perception varies by place of residence due to differences in biophysical vulnerability (Deressa et al., 2011; Hitayezu et al., 2017). On the other hand, living in an exposed area alone is not sufficient to raise risk perception unless accompanied by direct experience of a hazard (Lujala et al., 2015).

The theoretical orientations and the empirical works reviewed above show that a thorough understanding of climate change risk perception necessitates the consideration of multiple factors. van der Linden (2015) proposed and validated the 'Climate Change Risk Perception Model' that integrates cognitive, experiential, normative, and value-related factors as well as the socio-demographic characteristics. The model was tested empirically, and the variables explained 68% of the variation in risk perception. These theoretical constructs were adopted in this study to characterize households with varying levels of climate change risk perception. According to this model, climate change risk perception is a function of cognitive factors (i.e. knowledge), experiential processes (holistic affect and past experience), socio-cultural influences (i.e. social norm and value orientations), and socio-demographic characteristics of individuals/households.

## 3. Data and Methods

### 3.1. Selection of the study areas

The nature of vulnerability to CCV and the type of responses vary by agro-ecological setting. In Ethiopia, three major agro-ecological zones can be identified: highland, midland, and lowland. This study was conducted in three districts (Kimbibit, Kuyu, and Boset) in Central Ethiopia, representing highland, midland, and lowland areas, respectively. Since the districts are not exclusively categorized under the indicated agro-ecological zones, three *kebeles* (lowest administrative unit in Ethiopia) that are located in the specified agro-ecological settings were selected from each district. The selection of the districts was also made based on the consideration of similarity of livelihood systems and prevalence of climate-related risk factors. About 85% of their population lives in rural areas. Their livelihood is mainly dependent on mixed farming in which livestock production is integrated with crop production.

The average annual temperature of the highland, midland, and lowland areas is 14.6°C, 15.5°C, and 22.1°C, respectively. The average annual temperature of the lowland areas was significantly higher than that of the midland and highland areas, and that of the midland areas was significantly higher than that of the highland areas. The three areas are characterized by bi-modal rainfall distribution with a short rainy season between March and May, and a long rainy season between June and September. The long-term average rainfall of the short rainy season was 72, 177, and 81 mm in the highland, midland, and lowland areas, respectively. The long-term average rainfall of the long rainy season is 690, 944, and 384 mm in the same order. Following the two rainy seasons, farming activities are undertaken twice a year. However, farmers complain that they rarely produce crops during the short rainy season due to the failure of rainfall. Though less variable compared to the short rainy season, the long rainy season is characterized by a yearly variation in the time of onset and cessation, resulting in varying lengths of the crop growth period. In addition to rainfall variability, extreme events such as drought, flood, frost, and snow occur in the study areas to varying degrees. Consequently, the problem of food insecurity is widespread, and a sizeable proportion of the population is supported by the Productive Safety Net Program and emergency food aid.

### 3.2. Sample size and sampling techniques

The sample size of the study was determined using a sample size calculation for a finite population. The computational assumptions were 95% confidence interval; 5% level of significance; and 60% of households perceiving climate change and using adaptation strategies. Taking the population size of the district with the smallest number of households, the sample size was calculated to be 270 households. Considering each district as an independent unit, the total sample size was 810 households. A multi-stage sampling technique was used to identify sample households. The three districts and nine *kebeles* were selected through purposive sampling at the first and second stages, respectively. At the last stage, sample households were selected using a simple random sampling technique from the list of households living in each *kebele*.

### 3.3. Sources of data and methods of collection

Data were collected from the heads of the sampled households using survey questionnaire. It included information on risk perception; knowledge about climate change; past experience of climate-related events; norms; values; and demographic and socio-economic characteristics of the households.

### 3.4. Definition of variables

#### 3.4.1. Dependent variable

Risk perception, the dependent variable of the study, was measured using eight questions that comprehensively assess farmers' concerns about climate change and their readiness to take measures, adapted from Leiserowitz (2006) and van der Linden (2015). These questions, measured on a five-point scale, included concern about climate change; likelihood of its threat on household wellbeing; likelihood of its effect on the community; perceived seriousness of climate change to a household, a village, the local environment, and a district; and extent of worry about the effects of climate change. The questions were consistent for measuring risk perception with a high scale reliability coefficient (alpha = 0.93). The responses were added up to obtain the risk perception index, in which large numbers show a high level of risk perception. The index was then classified into three categories (low, moderate, and high) using the cumulative square root of the frequency method.

#### 3.4.2. Explanatory variables

The explanatory variables used in this study were knowledge, past experience of climate events, social norms, and values.

*Knowledge*: Farmers' knowledge about climate change was measured based on households' responses to 16 factual questions derived from empirical evidence. The responses were given as yes (1), no (0), and do not know (8). For each of the questions, less than 5% of the respondents chose 'do not know'. Given that this response reflects a lack of certainty, it was recoded as 0 when computing the knowledge index. During reliability testing, inconsistent items were dropped by running a 'Cronbach alpha statistic if an item is deleted', and 10 questions that were consistent for measuring knowledge (alpha = 0.74) were used in the final computation. These 10 questions refer to three domains of knowledge: cause of climate change (1 question), consequences of climate change (6 questions), and responses to climate change (3 questions). Since the Cronbach alpha statistic of each domain was low, they were not treated separately. The knowledge index was grouped to create three categories of responses (low, medium, high) following the cumulative square root of the frequency method.

*Affect and past experience*: Holistic affect was measured on a five-point scale based on a question of how farmers felt about the impact of climate change. Past experience related to climate change was measured by asking respondents whether they had experienced any of a range of climatic events (drought, flood, snowfall, frost, early termination of rainfall, delayed onset of rainfall, and waterlogging) during the last 15 years. It was a yes/no question, and the responses were added-up to get the number of events the respondents were exposed to. The variable was recoded into three categories (low, medium, high), with the cut-off point being determined using the cumulative square root of the frequency method.

*Social norms*: Two variables were used to measure norm: descriptive and injunctive norms. Descriptive norm (observation of peer experience) was measured by asking four questions, on a four-point scale, about whether the household head observed important others (relatives, neighbours, model farmers, and most farmers in their village) using different strategies to reduce the impact of climate change. Injunctive norm (encouragement by peers) was measured by asking questions on whether the household heads are encouraged by the four important others to use different strategies to respond to the threats posed by climate change. The two sets of questions were internally consistent for measuring the two norms with respective alpha values of 0.89 and 0.90.

*Values*: The questions used to measure the farmers' value orientations were adapted from a selected Schwartz's value scale. Self-transcendent vs. self-enhancement values were measured by asking questions about the farmers' endorsement of nature as object vs. nature as subject and solidarity vs. autonomy. On the other hand, openness-to-change vs. conservatism was measured based on farmers' endorsement of values such as tradition vs. change, societal responsibility vs. individual responsibility, risk avoidance vs. risk taking, and institutional knowledge vs. local knowledge. We used value pairs assuming that some farmers endorse certain value and others adhere to its counter-value. For each value pairs, the farmers were asked to indicate, on a five-point scale, their positions on how often they adhere to either of the two opposing values or both. Since households might be less rigid in adhering to either of the extremes, a third category of response was created for each value domain and labelled as 'both', which shows context-specificity in their inclination to either of the two extremes.

#### 3.4.3. Control variables

Previous studies have widely reported that perception is a function of the demographic and socio-economic characteristics of households (Chingala et al., 2017; Deressa et al., 2011; Hitayezu et al., 2017). These characteristics were considered control variables in this study. They are: age of household head (20-39, 40-59, 60+), sex of household head (male, female), educational level of household head (no education, primary or above), size of land owned (less than 1 hectare, 1–2 hectares, and greater than 2 hectares), economic status (low, medium, high, which was classified based on possession of farming tools and household equipment), access to media (no access at all, had access at least once a week), agro-ecological zone (highland, midland, lowland), and social capital (low, medium, high). Social capital was measured on a four-point scale using 12 questions emphasizing household heads' participation in community-based organizations, trust and reciprocity, and contact with locally based formal institutions. The questions were consistent for measuring social capital (alpha = 0.78).

### 3.5. Data analysis

The household survey data were analysed using descriptive statistics and the 'polling method'. Percentage distribution was used to illustrate variations in risk perception, knowledge, experience, norms, and values by agro-ecological setting. Cramer's V test was used to examine the significance of bi-variate association between risk perception and the explanatory variables. Then the polling method was applied to discern the risk perception profiles of the households.

Polling is the maximum likelihood prediction method of multivariate analysis involving the joint analysis of a large number of integer-valued explanatory variables (Keyzer & Pande, 2007). Unlike regression techniques in which the validity of the test results are based on the fulfilment of parametric assumptions, polling allows for non-parametric interactions between explanatory variables. In addition, the conventional regression techniques are less robust for categorical explanatory variables and for which the combination values are large in number relative to the number of observations and real-valued variables (van Wesenbeeck et al., 2016). Furthermore, the commonly used dummy variable approach allows for one equation per binary factor and lets all coefficients on the real-valued determinants differ freely across equations. To overcome these analytical limitations, this study employed the polling technique to identify the dominant association between the dependent variable and the explanatory variables.

This method jointly evaluates the roles of different explanatory variables in predicting the likelihood of having low or moderate or high risk perception. The joint empirical frequency distribution is defined from observed values of the explanatory

variables. Then, conditional frequency distributions are derived from this joint distribution by partitioning the answers by, e.g. S respondents indexed s into a vector y of dependent variable and a vector x of explanatory variables, taking the frequencies of y conditional on x (Keyzer & Pande, 2007; van Wesenbeeck et al., 2016). These conditional frequencies are interpreted as probability estimates of y given profile x. Hence, the most probable characteristics associated with each x value is the winner which has the highest probability of having the desired y outcomes. The coverage of a profile x is the mass of a class within profile x divided by the total mass of the relevant group. The edge of the winning profile over the runner up (i.e. the second best guess) is the ratio of their maximum likelihood probabilities (i.e. the share of the population covered by the most likely profile relative to the share covered by the runner-up). Selection of the best profile from the set of explanatory variables is based on the coverage and edge of each combination.

The number of explanatory variables included in the profile determines the coverage of the winning profile. While including a large number of explanatory variables in the profile yields a high degree of specificity, limiting the number in each profile yields a high coverage. This entails the need to attain a balance between the two. As shown in the study by van Wesenbeeck et al. (2016), the inclusion of more than five variables sharply decreased the coverage and edge of the winning profile. Hence, in this study, from the list of explanatory variables that have a statistically significant association with risk perception, all possible combinations of five explanatory variables were used to identify the profile of households having varying levels of climate change risk perception.

## 4. Results

### 4.1. Description of the sample

Most of the respondents were male household heads (86.7%). Slightly over one-third (36.8%) of the household heads were in the age group 20-39, while household heads in the age group 40–59 constituted 38.6% of the respondents. The remaining one-fourth were old household heads (60+ years). About two-thirds of the household heads had no formal education. Only 10.3% of those who had formal education had more than primary level education (i.e. further than grade eight). Slightly over one-third (35.1%) of the households had a small land size (i.e. less than 1 hectare). The respective percentages of households that had medium and large sizes of farmland were 27.4% and 37.5%. Close to one-fourth (22.2%) of the households had a low economic status, while 28% had a high economic status. The social capital of nearly one-third (30.1%) of the households was low, while one-fourth (25.4%) had high social capital. More than half (54%) of the household heads had no access to media, and the remaining household heads reported that they had access to media at least once a week.

### 4.2. Farmers' knowledge, experience, norms, and values

Figure 1 shows the variation in household heads' knowledge, experience, and social norms. Close to half of the household heads (47%) know a lot about climate change. While 36% of the household heads had a moderate level of knowledge, only 17% of the household heads had little knowledge. The proportion of households knowing a lot was relatively higher in the lowland areas and decreased slightly with altitude. Nearly all farmers (98%) in all districts felt the impact of climate change to be negative. Although the study areas are vulnerable to climate-related risks, less than half of the household heads (44.4%) reported past experience of climate events, while slightly over one-fourth (28.9%) had low experience. The highest percentage of households with high and low experience were observed in the midland and lowland areas, respectively. Most of the household heads (43.7%) had a low descriptive norm. The proportion of households with a low descriptive norm was relatively higher in the highland areas. In contrast, the injunctive norm was relatively higher in the midland

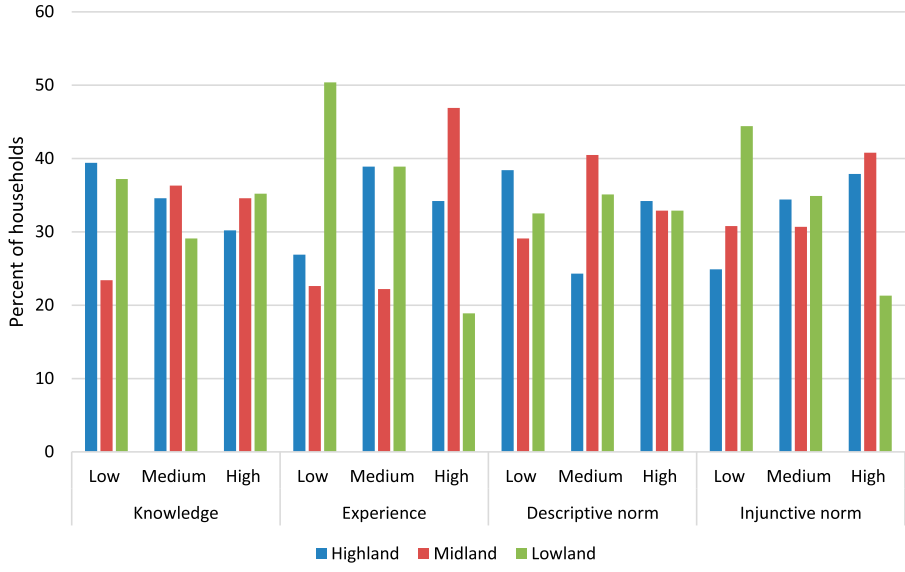


**Figure 1.** Percentage distribution of households' knowledge, experience, and norms by agro-ecological setting.

areas but lower in the highland areas. The proportion of households with a low injunctive norm increases inversely to altitude.

More than one-third of the household heads in the highland (38.5%), midland (36.6%), lowland (38.9%), midland (36.6%), and highland (38.5) areas valued tradition and change, change, and tradition, respectively (Figure 2). In the assessment of the responsibilities to overcome the threats of CCV, almost half of the household heads (49%) stated that it is the responsibility of both individual farmers and the government. The majority of the household heads (53%) were risk-averse. The proportion of risk-accepting households was relatively higher in the lowland areas (44.5%), while the proportion of risk-averse households was relatively higher in the midland areas (35.9%).

The distribution of households by value orientation is shown in Figure 2. The percentage of households valuing nature as object was relatively higher in the midland areas (50.8%). A noticeable percentage of households (41.5%) valued nature as both object and subject (i.e. using natural resources to fulfil own interest and also protecting them from misuse). Most of the farmers (37.5%) stated that they consider both their own interest (autonomy) and that of the community (solidarity) when they make decisions to take action to reduce the impact of CCV. A higher percentage of farmers who value solidarity was observed in the midland areas, while autonomy was valued by many farmers in both highland and lowland areas. Institutional knowledge was valued by most households (43.2%) for making decisions on actions to be taken to reduce the impact of CCV.

### 4.3. Profile of households with varying levels of risk perception

The percentage of households with a high perception was 40.1%. About one-fifth (21.4%) of the sampled households had a low risk perception, while 38.5% of the households had a moderate risk perception. There was a noticeable difference in risk perception between the study areas. The highest percentage of households with a high risk perception was observed in the midland areas (62.2), followed by the lowland areas (51.9). Among those with a low risk perception, 88.4% of them were households in the highland areas. On the other hand, among households that had a high risk perception, more than half (51.7%) were from the midland areas, while 43.1% were from the lowland areas. Only 5.2% of the households with a high risk perception were from the highland areas. The percentage of households with a moderate risk perception was nearly comparable across the three study areas, ranging from 30.4% in the midland areas to 37.5% in the lowland areas.

Climate change risk perception is a function of the interaction between different variables. Based on theoretical considerations and evidence from the empirical literature, 19 explanatory variables were identified. One variable (holistic affect) was dropped since almost all household heads had the same negative holistic affect. Then, Cramer's V test was employed to examine the bi-variate relationship between the remaining explanatory variables and the dependent variable to limit the number of variables to the most important ones. Accordingly, four variables (age, sex, injunctive norm, and risk preference) were excluded from polling due to their statistically insignificant association ($p>0.05$). Polling analysis using a combination of five explanatory variables from the list of 15 variables resulted in 3003 profiles for each response category of the dependent variable.

*High risk perception*: When the top 20 profiles of high risk perception were inspected, there was no profile that was high simultaneously in both coverage and edge. Hence, the profile that best balances the two was selected. As shown in Table 1, this profile has a coverage of 10% and edge of 2.28. Households with high climate change knowledge and experience had a high risk perception. Among the value orientations, households that value both societal (conservatism) and individual responsibility (self-direction) had a high risk perception. Denoting variation in risk perception by geographical location, households residing in the midland areas had a high risk perception. Contrary to expectation, lack of access to media was associated with a high risk perception.

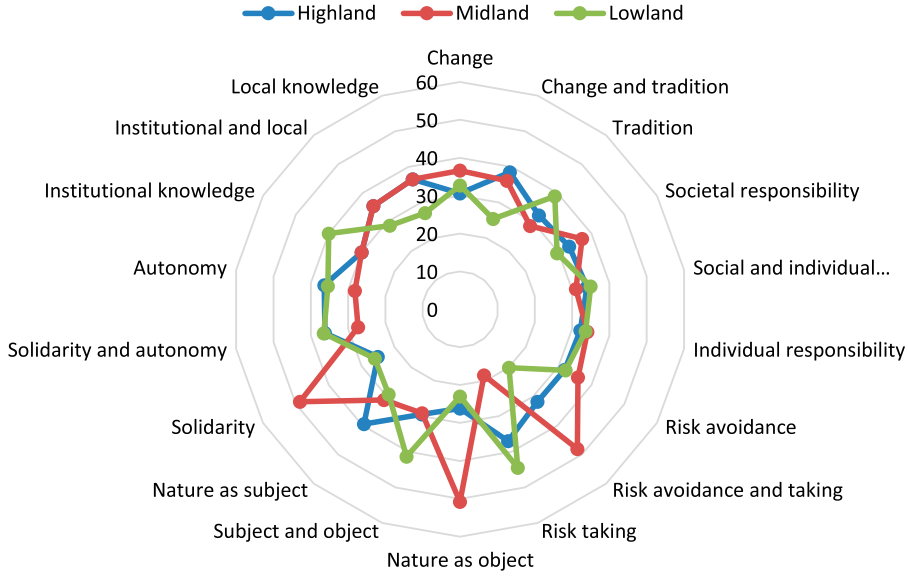


**Figure 2.** Percentage distribution of households' value orientations by agro-ecological setting.

**Table 1.** Winning profiles of high risk perception.

| Variables | Response categories | | | Winning profile |
|---|---|---|---|---|
| Access to media | Not at all | At least once a week | – | No access to media |
| Agro-ecological setting | Highland | Midland | Lowland | Midland |
| Knowledge | Low | Medium | High | High |
| Experience | Low | Medium | High | High |
| Value on responsibilities | Societal responsibility | Both | Individual responsibility | Both |
| Coverage | | 10% | | |
| Edge | | 2.28 | | |

**Table 2.** Winning profiles of moderate risk perception.

| Variables | Response categories | | | Winning profile |
|---|---|---|---|---|
| Knowledge | Low | Medium | High | High |
| Value on responsibilities | Societal responsibility | Both | Individual responsibility | Both |
| Value on the role of nature | Nature as object | Both | Nature as subject | Both |
| Value on group orientation | Solidarity | Both | Autonomy | Both |
| Value on trusted source of knowledge | Institutional Knowledge | Both | Local knowledge | Both |
| Coverage | | 14% | | |
| Edge | | 0.27 | | |

*Moderate risk perception*: With a coverage of 14% and an edge of 0.27, value orientations were the dominant factors in the winning profile of households with a moderate risk perception (Table 2). Households that value both societal and individual responsibility had a moderate risk perception. The result further shows that households that value nature both as object (self-enhancement) and subject (self-transcendent) had a moderate risk perception. Valuing both solidarity (self-transcendent/altruistic) and autonomy (self-enhancement/egoistic) also characterized households with a moderate risk perception. Value orientation that combines both institutional (openness to change) and local (conservatism) knowledge was among the features of households with a moderate risk perception. High level of knowledge about climate change was also associated with a moderate risk perception.

*Low risk perception*: This winning profile had a coverage of 15% and an edge of 2.51. The variables with winning profiles were educational level, access to media, social capital, descriptive norm, and value dilemma on solidarity and autonomy (Table 3). Households with a low risk perception had no education, no access to media, low social capital, and low descriptive norm. They predominantly valued autonomy (self-enhancement/egoistic).

## 5. Discussion

This study investigated the profile of households characterized by varying levels of risk perception. The results suggest that high climate change risk perception is a function of a high level of knowledge, high level of climate-related experience, value orientation that balances societal and individual responsibilities, lack of access to media, and living in the midland agro-ecological setting. Households with a moderate risk perception are characterized by a high level of knowledge, as well as values that balance societal and individual responsibilities, consideration of nature as subject and object, solidarity and autonomy, and institutional and local knowledge. On the other hand, lack of education and access to media, low social capital and descriptive norm, and endorsing autonomy explain a low risk perception.

### 5.1. High risk perception profile

The finding that climate change risk perception is high when households have a high level of knowledge about climate change is consistent with other studies (Sundblad et al., 2007; van der Linden, 2015). There are several mechanisms through which knowledge may favourably shape risk perception. Households with correct knowledge are less likely to misperceive climate change. There are misconceptions related to climate change in Ethiopia. These include, but are not limited to, attribution of the cause of climate change to the will of God as well as weakened indigenous practices (Ayal & Leal Filho, 2017; Hameso, 2017). In the study areas, there were participants who indicated that climate changes because of the wrong deeds of human beings in respecting their culture, as a result of which God penalizes them by denying rainfall. Such an externalization of the problem of climate change is highly likely to produce risk misperception, in which climate change is considered inevitable and unavoidable (Ayal & Leal Filho,

**Table 3.** Winning profiles of low risk perception.

| Variables | Response categories | | | Winning profile |
|---|---|---|---|---|
| Educational level | No education | Primary and above | – | No education |
| Access to media | Not at all | At least once a week | – | No access to media |
| Social capital | Low | Medium | High | Low |
| Descriptive norm | Low | Medium | High | Low |
| Value on group orientation | Solidarity | Both | Autonomy | Autonomy |
| Coverage | | 15% | | |
| Edge | | 2.51 | | |

2017). Conversely, correct knowledge helps people to understand the role of human beings in climate change, the consequences of climate change if not abated, and the possible responses that would reduce the impact. Such knowledge has an error-correcting effect on misperceptions and wrong beliefs (Guy et al., 2014) and also avoids cognitive bias (Hitayezu et al., 2017). This increases the farmers' risk perceptions.

More knowledge about climate change reduces under- or overestimation of risks, feelings of powerlessness to take action, and the negative impact of values. With lack of knowledge, there is a risk of inaccurately estimating risks (Stoutenborough & Vedlitz, 2014). This estimation, in turn, reduces the chance that households correctly perceive the threats of CCV. Owing to a lack of correct knowledge, farmers may feel powerless to overcome the problem and become less concerned about it (Tobler et al., 2012). Getting evidence-based knowledge about CCV leads to an understanding of climate change (Wolf & Moser, 2011). When knowledge about CCV increases, acclimate change knowledge increases correspondingly (Tobler et al., 2012). Knowledge about climate change also plays a useful role in reducing the impact of value on climate change belief. For instance, Guy et al. (2014) showed that knowledge attenuates the negative effect of individualism on the belief that climate change is occurring. In rural Ethiopia where misperceptions about climate change are partly rooted in societal values, evidence-based climate change knowledge is likely to alter these values and raise their risk perception.

Past experience of climate events is associated with a high risk perception. Experience as an influencing factor of risk perception has been reported in previous studies (Akerlof et al., 2013; Frondel et al., 2017; Spence et al., 2011). The role of experience in raising risk perception is partly related to its effect on memory. Due to its strong impact on memory and behaviour, personal experience is a great teacher shaping risk perception (Akerlof et al., 2013; Marx et al., 2007). In the experience-based risk assessment, risk perception relies on the extent to which the occurrence of a hazard creates feelings of fear and worry (Slovic et al., 2004). Hazards that evoke these feelings are perceived to be riskier. Accordingly, direct experience of climatic events creates strong emotions/feelings that make them more memorable and are used predominantly in processing risks (Dessai et al., 2004; Loewenstein et al., 2001; Marx et al., 2007). Experiential processing also helps farmers to relate current situations to memories of their past experience, based on which they define and frame a risk.

Experience raises risk perception by reducing the cognitive burden of analysing climate information. People learn about climate change from statistical descriptions and personal experience (Weber, 2010). Owing to the high level of illiteracy and low access to media in rural areas of Ethiopia, the role of analytical processing as a means to know about climate change is negligible. Hence, it is highly likely that farmers predominantly rely on associative and affective processes of learning about and perceiving climate change. Learning from personal experience is fast, vivid, automatic, and efficient to deal with complex and uncertain risks (Weber, 2010). Farmers can perceive the risk of CCV without consciously recognizing information processing pertaining to the occurrence and impact of climate hazards.

Experience helps farmers to overcome the disadvantage of not correctly observing long-term changes in temperature and rainfall. Given that climate change is a statistical phenomenon of change in average weather conditions, people may not easily observe and accurately describe it (Ayal & Leal Filho, 2017; Weber, 2010). However, experiencing climate change based on easily visualized events influences risk judgement and increases risk perception more than changes in average temperature and rainfall (Sundblad et al., 2007). Households might change their perception favourably in response to frequently facing a hazard. Experiencing an event may motivate people to seek further information about the event that helps them improve their understanding and perception of its impact.

Values play an important role in the variation in concern about climate change (O'brien, 2009). Households with a high risk perception are characterized by a value that balances the responsibilities of the government and individuals to take action to reduce the impact of CCV. When households do not totally externalize and feel that they are individually responsible for the solution, it is likely that they will raise their risk perception. This finding might be related to self-determined motivations in which such people 'experience themselves as initiators of their own behaviour, they select their own desired outcomes and choose how to achieve them' (De Groot & Steg, 2010, p. 369).

Access to media constitutes the winning profile of farmers with a high risk perception. This suggests that media are not important in gathering knowledge, as personal interaction and direct learning from others predominate in the Ethiopian rural setting. Farmers in the midland areas have a higher risk perception than farmers in the highland and lowland areas. This might be related to the repeated occurrence of extreme climate events in these areas. In the highland and lowland areas, farmers stated that there is a long history of cold weather and drought, respectively. In the midland areas, farmers perceived a recent increase in high-intensity rainfall and landslide. While exposure to adverse weather conditions for a longer time may lead to its consideration as normal, the perceived recent increase in extreme events seemed to have raised the risk perception of farmers in the midland areas.

### 5.2. Moderate risk perception profile

The profile of households with a moderate risk perception is characterized by four value orientations, along with a high level of knowledge. Valuing nature as both object and subject, balancing both solidarity and autonomy, and trust in the use of both institutional and local knowledge characterize households with a moderate risk perception. These results are fairly consistent with the findings that self-transcendent as well as altruistic and biospheric values promote environmental concern and raise climate change risk perception (De Groot & Steg, 2010; Schultz & Zelezny, 1999; Stern et al., 1999). For households concerned about climate change, the role of natural resources does not merely serve the interest of individuals. Nature is also a subject that should be conserved and used wisely. As Milfont and Duckitt (2004) noted, this denotes complementarity between the preservation and utilization of

natural resources. In their words, 'environmental sustainability implies that humans need to use natural resources for human wellbeing, but also need to protect the environment at the same time, that is, a balance of utilization with preservation' (p. 300). Furthermore, for households with a moderate risk perception, decisions on the actions to be taken to reduce the impact of CCV are evaluated based on both solidarity and autonomy, which is a balance of self-transcendent and self-enhancement values. The profile of these households reflects social cohesion and openness to institutional and other kinds of advice. However, moderate risk perception is not bounded to agro-ecological settings and socio-demographic variables.

### 5.3. Low risk perception profile

Our result suggests that a low descriptive norm and endorsing autonomy are associated with a low risk perception. According to Huber et al. (2018), social norms influence behaviour through the logic of appropriateness (i.e. consideration of an action as appropriate) and consequentialism (i.e. social pressure to comply with what others do). Although Huber and colleagues conceptualized it in terms of fear of social sanctions, consequentialism also denotes that farmers decide to behave in a certain observed manner being cognizant of the positive and negative consequences of their decisions. Adherence to either of the two rationales depends on group membership in which individuals follow the norm of a group that appears most salient at a given moment. Since the behaviour of important others is observable, a descriptive norm requires a simple cognitive assessment (Melnyk et al., 2011). Hence, when cognitive resources are limited, the influence of a descriptive norm on behaviour is high (Melnyk et al., 2011), and compliance with a descriptive norm mainly follows a heuristic shortcut that reduces the cognitive effort required for decision-making (Farrow et al., 2017). In such a case, imitation can even suffice to adopt the behaviour of others. However, the opportunity to align one's perception with group members is constrained when the descriptive norm is low. In all of our study areas, group membership was mainly based on reciprocity. For those who lack resources (e.g. labour, money), involvement in groups is limited. Consequently, households with a low descriptive norm are less likely to obtain group information, learn from 'important others' at low cost, and properly define risk. Risk perception is low when households adhere to the value of autonomy, which is egoistic self-enhancement behaviour focusing on individual interest in decision-making. This is consistent with studies showing that individuals with egoistic value have a low risk perception and are less likely to act pro-environmentally (De Groot & Steg, 2010).

Among the socio-demographic factors, lack of education and low social capital characterize households with a low risk perception. Education positively influences risk perception in multiple ways. First, higher education is associated with greater knowledge about the causes, consequences, and responses to climate change (Tobler et al., 2012), which in turn increases risk perception. Second, education enhances the analytical processing of climate information, improving farmers' perception of the risks of CCV. The disadvantage associated with low social capital is a lack of access to information that would be used to raise awareness. Since personal experience can be obtained from the stories of other persons (Marx et al., 2007), low social capital reduces the opportunity to grasp the experience of other people which would raise their concern about climate change. With limited involvement in groups, farmers miss the opportunity to positively change their normative behaviour through group interaction.

Households with a low risk perception are also characterized by a lack of access to mass media. This may be related to the combination of low social capital (no exposure to direct learning) and lack of access to media that jointly leads to low risk perception. In other words, the lack of social capital is not 'compensated' by access to media information and knowledge. In the absence of opportunities to learn through social interaction, media can play a role in raising risk perception in various ways. First, it can broadcast factual information about climate change which increases the farmers' knowledge, leading to a high risk perception. Second, media can enhance experiential processing by broadcasting past events and vicarious experience (Akerlof et al., 2013), which reactivates memories to raise people's concern about climate change (Lujala et al., 2015). Third, given that social norms affect behaviour only when they are salient (Cialdini et al., 1991), media can be used to broadcast messages that would increase the salience of existing social norms, thereby favourably shaping risk perception. Hence, households' lack of access to media, through the absence of information, constrains the utilization of these opportunities.

### 5.4. Limitations of the study

Although the strengths of this study consist of the large research sample and the innovative multivariate polling analysis, there are also limitations. First, polling analysis shows only the characteristics of households with low, moderate, or high risk perception. Hence, further study is required to prove causal links between risk perception and the explanatory variables, which are interpreted and discussed in the related literature in this paper. Second, the relationship between risk perception and knowledge, experience, norm, and values is non-linear. For instance, risk perception may be the function of values, and values may be the function of personal experiences (Broomell et al., 2015). Likewise, knowledge shapes perception and vice versa. This forward and backward linkage and the pathways through which they influence each other demand further inquiry. Lastly, although it is assumed that risk perception is a prerequisite for action, high climate change risk perception may not necessarily lead to taking adaptation action. This also warrants further investigation.

## 6. Conclusion

We measured risk perception using eight questions that comprehensively assess farmers' concerns about climate change and their readiness to take measures. Our 'Polling analysis' used a combination of five explanatory variables from the list of 15 significant variables, resulting in one winning farmer profile using five explanatory variables in each of the three classes of risk perception. These three different profiles have

been compared with the literature and gave rise to consistent and unexpected results which are nevertheless understandable and typical for the Ethiopian study areas and noteworthy for agricultural policies in Africa. Despite the vulnerability of their livelihood system to climatic hazards, farmers in the study areas showed at least three different levels of risk perception. Risk is properly perceived when farmers have accurate knowledge about CCV. In addition, a high experience of climatic events in the past raises concern as it creates inevitable effects on the livelihood of farmers. The findings of our study suggest that self-transcendent and openness-to-change values are associated with a high climate change risk perception of smallholder farmers in Central Ethiopia. Conversely, risk perception is low among farmers endorsing self-enhancement value (i.e. autonomy). In the rural settings of Ethiopia where social interaction is the dominant way of learning, a low descriptive norm, compounded by low social capital, is a barrier for normative messages to increase risk perception. The low socio-economic profile of farmers with a low risk perception further suggests that the adverse effects of climate events might have created a feeling of 'out of control' which is mainly a panic kind of risk perception.

The profile of households with three levels of risk perceptions gives further insights into and has important implications for risk communication strategies to be used at a local level to increase their concern about and engagement with climate change. Raising the farmers' evidence-based knowledge about climate change improves their mental models of the linkages between causes, consequences, and responses (Broomell et al., 2015), which helps in favourably shaping their risk perception by avoiding scepticism, if any, about the problem, misconceptions associated with the causes of CCV, and the possible actions to be taken to reduce its impact. This is particularly important in rural areas of Sub-Saharan Africa where there is a high rate of illiteracy, and misperceptions and wrong beliefs that are more likely to cause risk misperception and maladaptation are predominant. The positive effect of past experience on risk perception entails the important roles of communicating messages focusing on vicarious experience and salient normative behaviour that help farmers to easily envisage the impacts of climate-related events and their roles in taking action. Communication of vicarious experience should also pay due attention to the occurrence of counterproductive emotions such as feelings of fear and hopelessness (Wolf & Moser, 2011). Since farmers often evaluate and interpret information in line with pre-existing values (Corner et al., 2014; Whitmarsh, 2011), communication messages that acknowledge the value orientations of the community are likely to be successful in gaining their trust. Communication messages are expected not only to be sensitive to the values of the community but also to strengthen values that favour concern for climate change and willingness to take action. More specifically, messages that foster self-transcendent values as well as openness to change in the long-term would raise the perception of farmers to engage them in adaptation responses. Risk communication strategies should also be context-specific in considering practical climate-related problems that farmers face in different agro-ecological settings.

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